HWG | HARRIS, WILTSHIRE & GRANNIS LLP

August 22, 2019

<u>Ex Parte</u>

Marlene Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz*, GN Docket No. 17-183

Dear Ms. Dortch:

On August 20, 2019, representatives of Hewlett Packard Enterprise, Broadcom Inc., and Harris, Wiltshire & Grannis LLP met with staff from the FCC's Office of Engineering and Technology. A complete list of attendees is attached. We discussed the attached presentations. The first presentation demonstrates that individual RLAN devices use only a tiny fraction of the available airtime, even when being used for data-intensive applications such as HD video streaming. As we explained, this highly efficient use of airtime supports RLAN devices' ability to share spectrum with incumbents and demonstrates that aggregate interference protection is not needed due to the low duty cycles of typical RLAN transmissions.

The second presentation demonstrated, again, that low-power indoor RLAN operations in the 6 GHz band do not pose any significant risk of harmful interference to fixed-service ("FS") links. To illustrate the findings of this presentation, we provided an interactive demonstration of an RLAN simulation tool that analyzes nearby FS links given an RLAN location, power level, height, and other relevant parameters, and then calculates the I/N value at specific FS receivers that would result from transmissions from that simulated RLAN device, as illustrated in the attached materials. Our demonstration confirmed that there is no risk of harmful interference from low-power indoor RLANs.

Pursuant to the FCC's rules, I have filed a copy of this notice electronically in the above referenced dockets. If you require any additional information, please contact the undersigned.

Sincerely,

Paul Margie
Counsel to Hewlett Packard Enterprise and Broadcom Inc.

Enclosure
Cc: Meeting Participants

MEETING PARTICIPANTS

Hugh Van Tuyl (FCC OET)
Bahman Badipour (FCC OET)
Barbara Pavon (FCC OET)
Michael Ha (FCC OET)
Nicholas Oros (FCC OET)
Aspasia Paroutsas (FCC OET)
Aole Wilkins El (FCC OET)*
Ira Keltz (FCC OET)

Chris Szymanski, Broadcom Inc.
Chuck Lukaszewski, Hewlett Packard Enterprise
Peter Thornycroft, Hewlett Packard Enterprise
Paul Margie, Harris, Wiltshire and Grannis LLP
Paul Caritj, Harris, Wiltshire and Grannis LLP

*Participated via telephone

Packet Captures of Video Buffering over Wi-Fi on Common Cloud Services

August 20, 2019

Summary

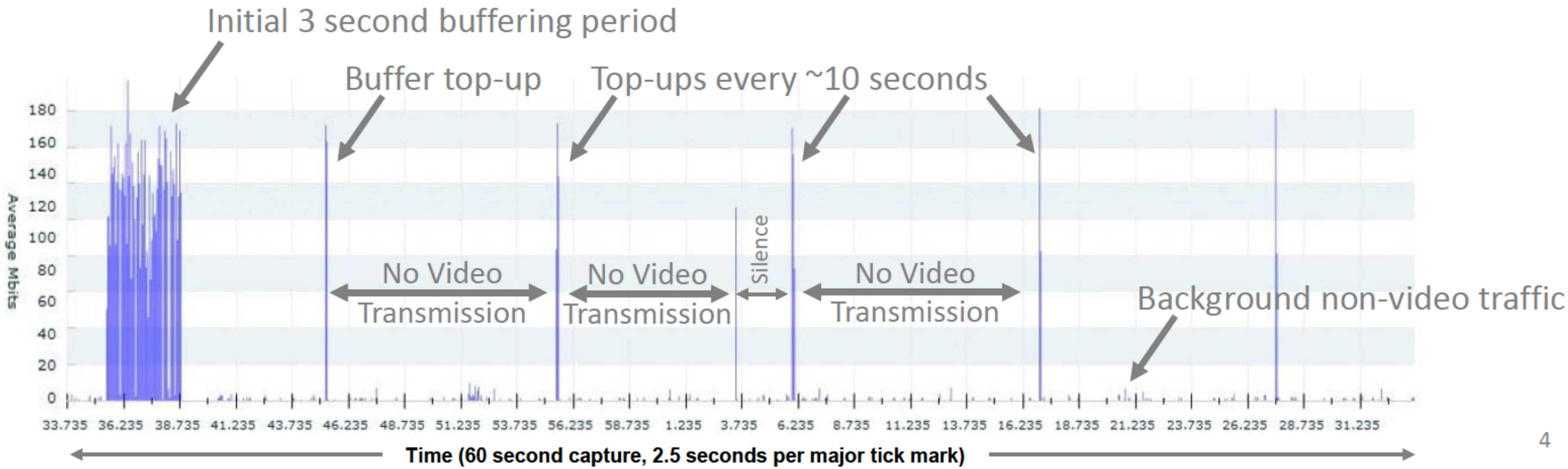
- The residential Wi-Fi busy hour is dominated by video traffic.
- There is no direct linkage between the **video bitrate** and the **over-the-air** bitrate:
    - Video transmission is highly optimized to minimize network consumption and delivery cost, using state of the art variable bitrate encoders, per-title encoding, and adaptive codecs that reduce playback bitrates based on screen size and user-perceived quality.
    - Video is sent in blocks by servers and buffered on the user device to provide the illusion of continuous streaming.
    - Blocks are sent at the highest available Wi-Fi bitrate, and combined using packet aggregation such that numerous blocks are sent in a single transmission. For example, a “5 Mbps” video stream would be sent at up to 1.2 Gbps on a 2SS 802.11ax access point.
- Video blocks are sent with gaps of 1 to 10 seconds between blocks, depending on video quality and user screen size.
    - There are **no video transmissions between blocks**. The wireless medium is idle for that video stream.
- To illustrate these behaviors, we provide over-the-air lab measurements of three major video encoding rates (720P, 1080P and 4K) on two popular services (Netflix and YouTube).
- The measurements corroborate explanations by RLAN proponents that a low duty cycle is appropriate for estimating aggregate busy hour traffic.

Test Procedure

1. Measurements were carried out with a current HPE Aruba 802.11ac Wave 2 compliant access point (AP).
2. The test client was a widely available laptop, with a two spatial stream 802.11ac radio. The laptop was connected to an external 4K monitor over an HDMI cable.
3. The AP and client were in an echoic test chamber on the 80 MHz channel 36E with high SNR levels. The PHY data rate was 866 Mbps, which represents the 802.11ac peak modulation of MCS9 256QAM 5/6 coding. A dedicated, high-performance packet capture laptop was used to capture wireless traffic.
4. The test procedure was as follows for both YouTube and Netflix:
   - Start video and set video quality
   - Start 300 second packet capture
   - Move video to new starting point to clear and restart client buffer
   - Stop capture and store file
5. The test sequences were as follows:
   - YouTube – 720P, 1080P, and 4K – Video source: https://www.youtube.com/watch?v=D6tC1pyrsTM
   - Netflix – 720P and 1080P – Video Source: Planet Earth II: Episode 6

YouTube 720P

- We measured a 3.2 Mbps average bitrate over 300 seconds.
- This was composed of an initial 3 second period of buffering, followed by extremely brief buffer "top-ups" with a periodicity of about 10 seconds between top-ups.



Typical Structure of Over-the-Air Video Block

- Video blocks are sent at 866.7 Mbps PHY rate (256 QAM).
- Each block consists of an OTA burst of many individual IP video packets.
- The example below shows one burst of 40 IP video packets, sent as 20 MPDUs of 3,076 bytes each, which consume a total of 0.8 milliseconds.

Packet	Source	Destination	BSSID	Channel	Data Rate	Size	Absolute Time	Protocol	Application
5894	71:3A:0E:4E:BF:B0	34:13:E8:53:CD:75		36	6.0	20	22:28:54.100803	802.11 RTS	
5895		70:3A:0E:4E:BF:B0		36	6.0	14	22:28:54.100829	802.11 CTS	
5896	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101021	HTTPS	IP
5897	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101031	HTTPS	IP
5898	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101039	HTTPS	IP
5899	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101046	HTTPS	IP
5900	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101073	HTTPS	IP
5901	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101081	HTTPS	IP
5902	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101106	HTTPS	IP
5903	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101131	HTTPS	IP
5904	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101156	HTTPS	IP
5905	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101180	HTTPS	IP
5906	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101201	HTTPS	IP
5907	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101226	HTTPS	IP
5908	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101248	HTTPS	IP
5909	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101280	HTTPS	IP
5910	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101316	HTTPS	IP
5911	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101340	HTTPS	IP
5912	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101362	HTTPS	IP
5913	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101401	HTTPS	IP
5914	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101428	HTTPS	IP
5915	23.246.59.238	10.10.0.222	70:3A:0E:4E:BF:B0	36	866.7	3076	22:28:54.101453	HTTPS	IP
5916	34:13:E8:53:CD:75	70:3A:0E:4E:BF:B0		36	24.0	32	22:28:54.101608	802.11 BA	

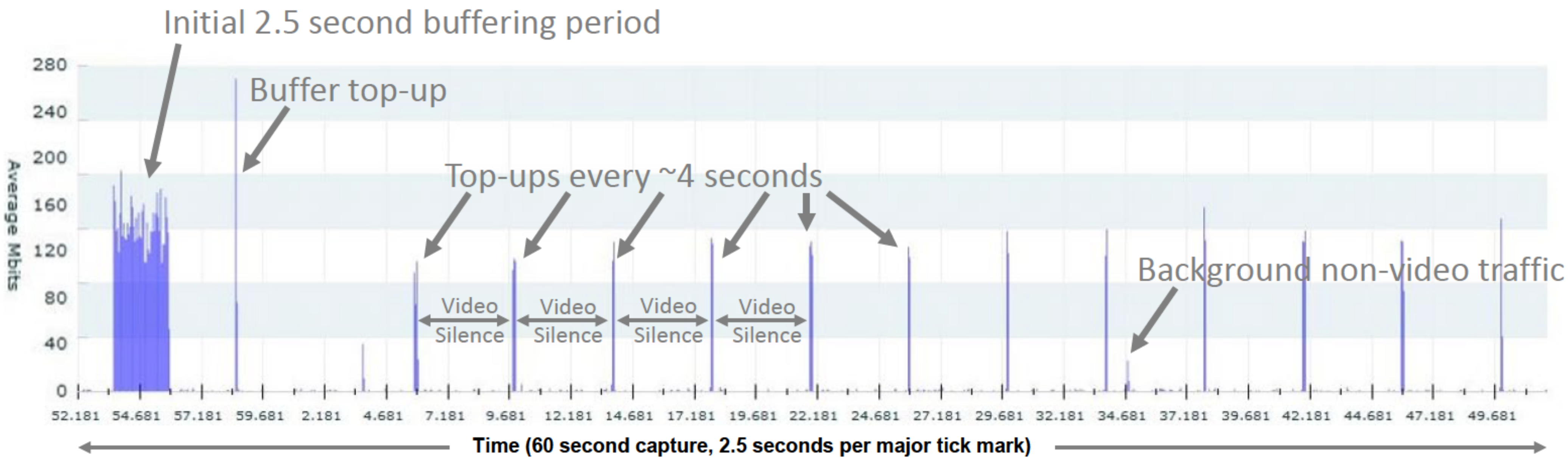
Acquire channel

20 individual video MPDUs sent at 866.7 Mbps data rate

Acknowledgement (0.8 msec after start)

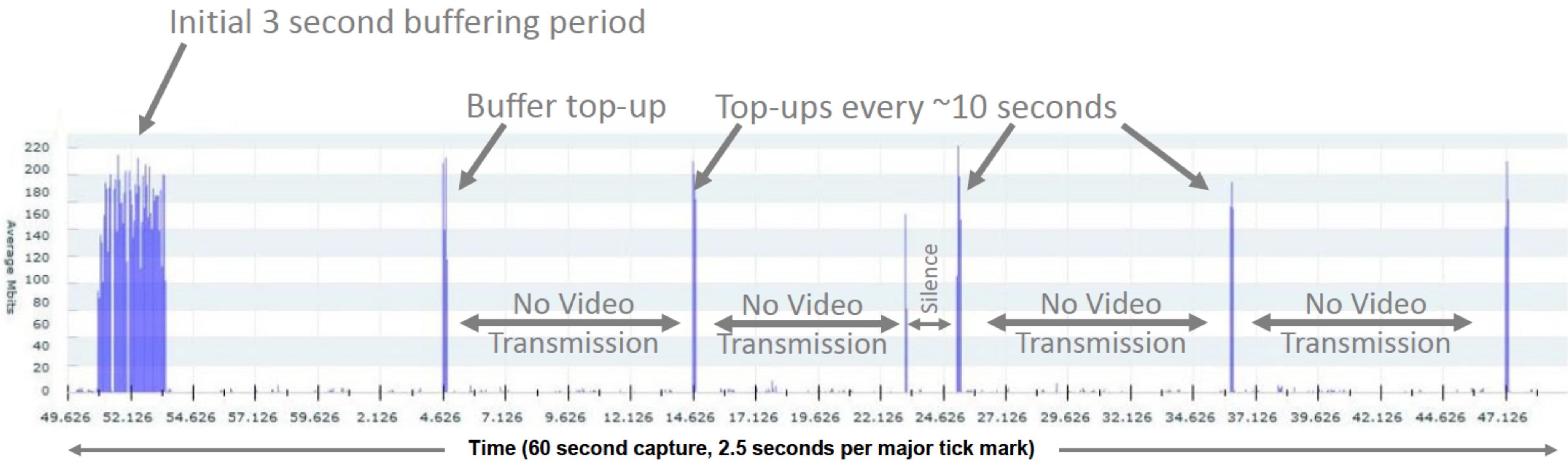
Netflix 720P

- We measured a 4.5 Mbps average bitrate over 300 seconds.
- Netflix 720P uses a ~2.5 second initial buffer period. Top-up periodicity was measured at just over 4 seconds.



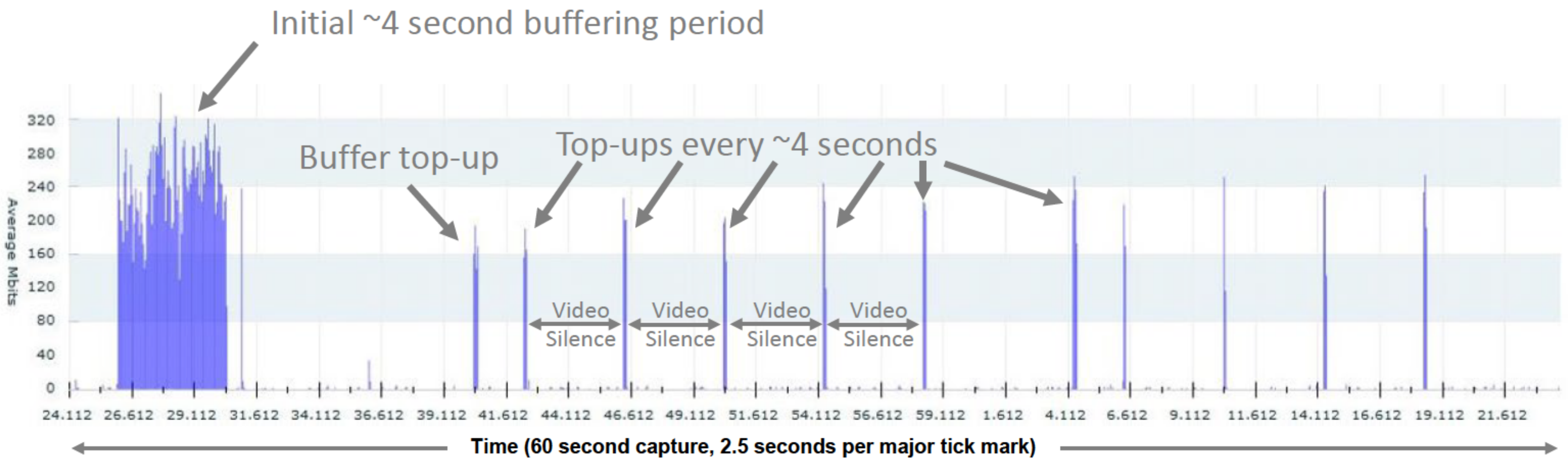
YouTube 1080P

- We measured a 4.5 Mbps average bitrate over 300 seconds.
- YouTube's ~3 second initial buffer and ~10 second top-up interval are identical to 720P.
- The average bitrate per block is higher (215 Mbps for 1080P vs. 170 Mbps for 720P).



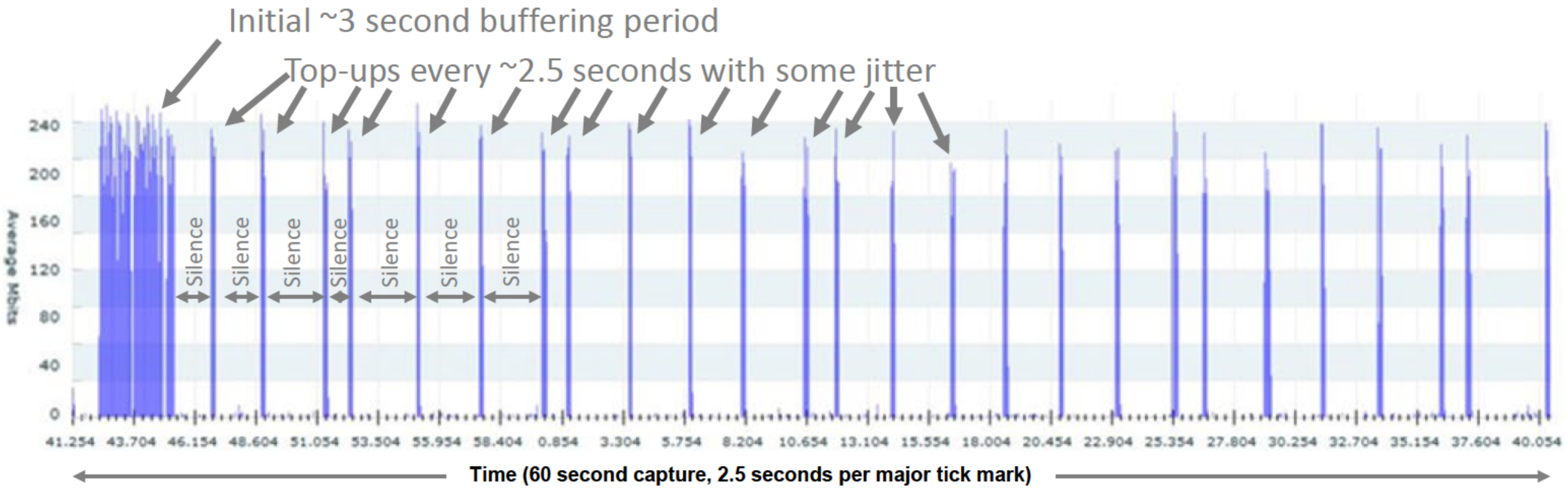
Netflix 1080P

- We measured a 8.4 Mbps average bitrate over 300 seconds.
- Netflix 1080P has a longer initial buffer rate of 4 seconds (vs. 2.5 seconds for 720P).
- The average bitrate per block is higher (220 Mbps for 1080P vs. 130 Mbps for 720P).



YouTube 4K UHD

- We measured a 20.9 Mbps average bitrate over 300 seconds.
- YouTube's ~3 second initial buffer is same as 720P/1080P.
- The average bitrate per block is higher (230 Mbps for 4K vs. 215 Mbps for 1080P).



History of Video Bitrate Improvements

- As a general rule, the bitrate required to deliver a given user-perceived video quality level at a given resolution decreases over time with advancements in coding efficiency, encoding algorithms, and forward error correction, among other factors.
  - For example, École Polytechnique Fédérale de Lausanne (EPFL) did a study to evaluate the subjective video quality of HEVC at resolutions higher than HDTV. The study was done with three videos with resolutions of 3840×1744 at 24 fps, 3840×2048 at 30 fps, and 3840×2160 at 30 fps. The subjective bit rate reductions were determined based on subjective assessment using mean opinion score values. The study compared HEVC MP with H.264/MPEG-4 AVC HP and showed that, for HEVC MP, the average bitrate reduction based on PSNR was 44.4%, while the average bitrate reduction based on subjective video quality was 66.5%. Other studies have shown similar results. [1]
- Netflix has described its transition from static encoding ladders to per-title encoding, which can achieve significant reductions in the required bitrate to achieve the same perceived quality.
  - For example, for the show Orange is the New Black, per-title encoding now requires only 4640 Kbps as compared with the 5800 Kbps previously required by their fixed bitrate ladder scheme. [2]
- Therefore, video bitrate values measured in any particular year for any given combination of encoder resolution, user screen size, video playback codec, and even specific video file will decrease over time.
  - All major cloud video providers target ~5 Mbps for HD video.

References

[1] Philippe Hanhart, Martin Rerabek, Francesca De Simone, and Touradj Ebrahimi, *Subjective quality evaluation of the upcoming HEVC video compression standard*, École Polytechnique Fédérale de Lausanne (2012), https://infoscience.epfl.ch/record/180494/files/hanhart_SPIE2012_1.pdf.

[2] Per-Title Encode Optimization, Netflix Technology Blog (Dec. 14, 2015), https://medium.com/netflix-techblog/per-title-encode-optimization-7e99442b62a2.

Demonstration of Low Power Indoor RLAN I/N from High-Rise Buildings in New York City & Washington DC

Summary

- We have reviewed the four major factors that drive the calculation of I/N levels caused by RLANs: RLAN EIRP, building entry loss, path losses, and off-axis rejection.[1]
- We have also shown, via a high-resolution Lidar geospatial analysis, that:
    1. Few FS paths in the NYC metro area have a high-rise building protruding into the main beam;
    2. Just 2.7% of paths could have a slight exceedance beyond -6 dB I/N for an LPI RLAN; and
    3. The median C/N of urban NYC FS paths is 67 dB, so slight exceedances will not cause harmful interference.[2]
- Today, we bring together both of those presentations with a demonstration of a tool that performs real-time I/N calculations for hypothetical RLANs.
    - We will revisit five of the high-rise building examples from July 29 using the tool and provide a live sensitivity analysis of the various factors.
- Low Power Indoor (LPI) and Very Low Power (VLP) are device classes that are vital to the future viability of the 6 GHz band.
- The Commission should allow LPI across the entire 6 GHz band and VLP as we have proposed in U-NII-5, U-NII-7 and the lower 100 MHz of U-NII-8.

[1] *See* Letter from Paul Margie, Counsel to Apple, Inc., Broadcom Inc., Cisco Systems, Inc., Facebook, Inc., and Hewlett Packard Enterprise, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295 and GN Docket No. 17-183 (filed June 24, 2019).
[2] *See Lidar Study of High-Rise Buildings in Fixed Service 3dB Beams in New York Metropolitan Area* (July 2019), *as attached to* Letter from Paul Margie, Counsel to Apple, Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, Hewlett Packard Enterprise, and Microsoft Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 18-295 and GN Docket No. 17-183 (filed July 31, 2019).

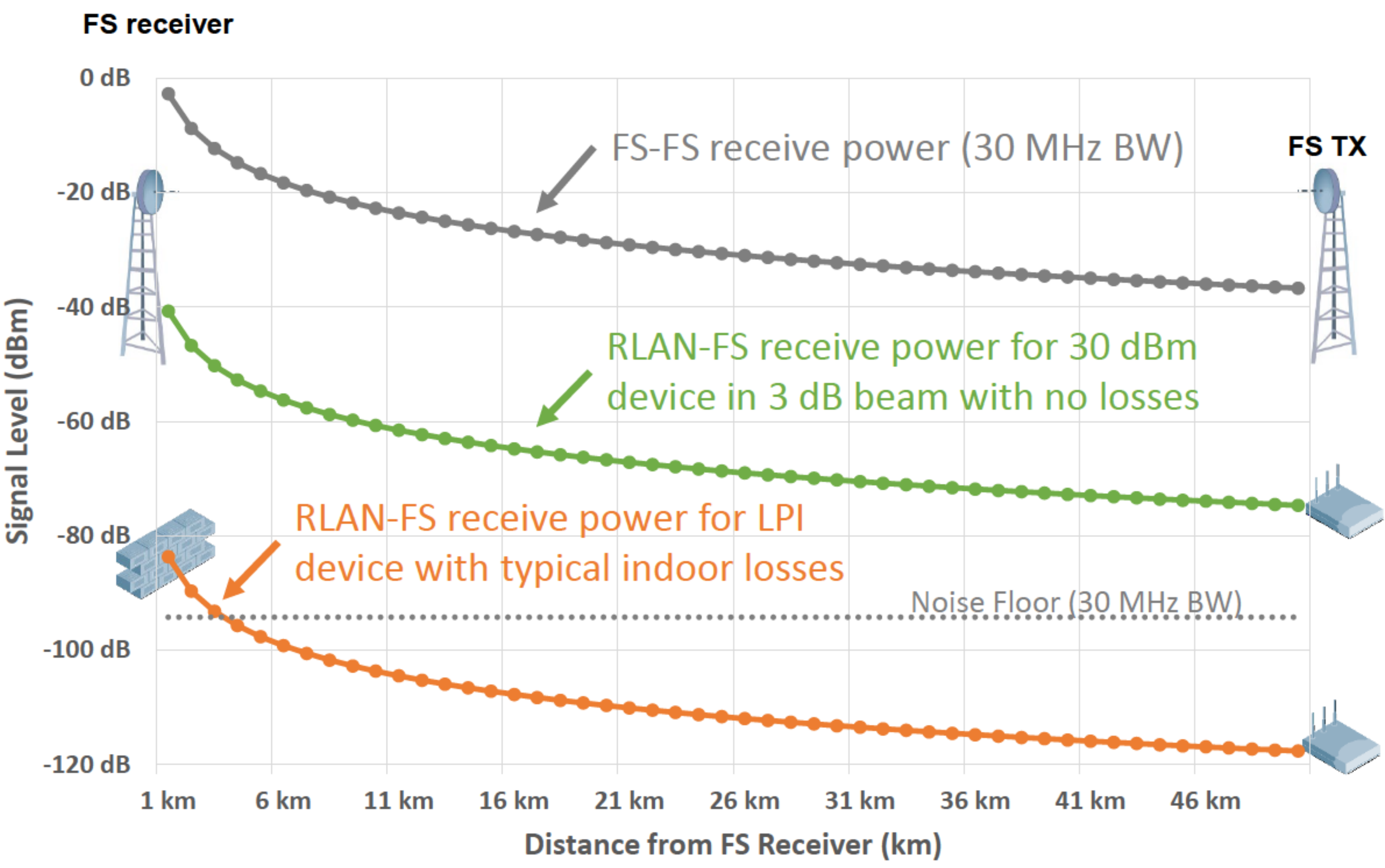
About the HPE RLAN Simulator

- HPE and Federated Wireless have developed a tool that enables a user to "drop" an RLAN device anywhere in CONUS.
- The tool calculates spectrum availability based on I/N exceedance to 1 MHz granularity.
- The tool employs precomputed terrain-aware FS receiver (FSR) protection contours using the USGS National Elevation Dataset 1 arc-second resolution.
- The tool implements the RLAN Group path loss model per our NPRM Comments,[3] using the 2011 National Land Cover Database to determine applicable model and ignoring P.2108 clutter for RLANs above 50 meters so that ITM model approximates free-space path loss.
- The tool uses data available in ULS as of February 2019 for FS links.

[3] *See* Comments of Apple Inc., Broadcom Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, Hewlett Packard Enterprise, Intel Corporation, Marvell Semiconductor, Inc., Microsoft Corporation, Qualcomm Incorporated, and Ruckus Networks, an ARRIS Company at 43-44, ET Docket 18-295 (filed Feb. 15, 2019).

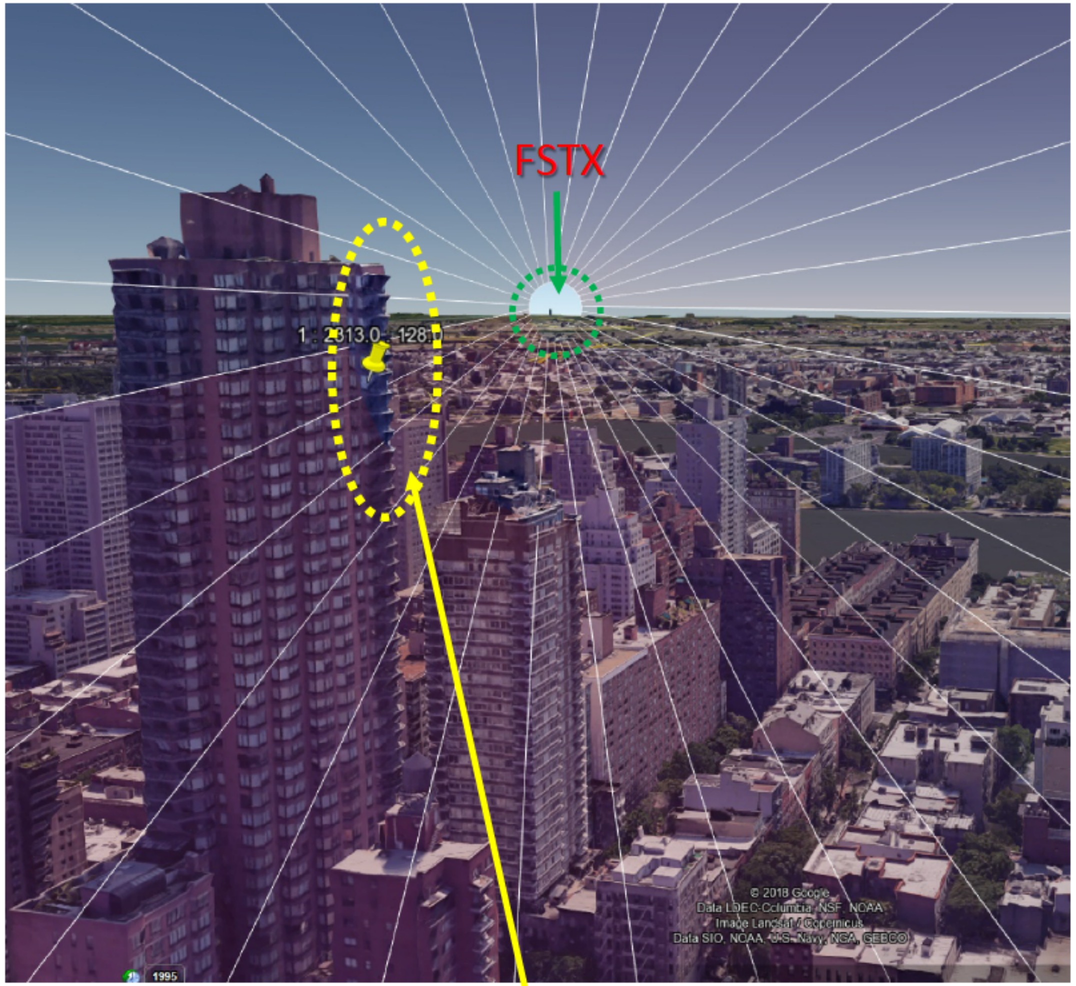
Typical Indoor RLAN Power Levels and RLAN-FS Path Losses from High-Rise Buildings Mitigate Interference Risk Beyond 7 Kilometers

- Numerous filings in the record document that virtually all high-rise buildings are thermally efficient (30 dB BEL) for structural reasons.
- We have repeatedly documented losses that apply to LPI/VLP indoor scenario including:
    - Polarization mismatch – 3 dB
    - FS feeder loss – 2 dB
    - Bandwidth mismatch – 5 dB *(typical)*
    - FS off-axis rejection - *Varies*
    - RLAN antenna mismatch – 5 dB *(typical)*
- Even ignoring the fact that RLANs typically operate well below maximum EIRP, they only exceed the noise floor to 3 km, and only exceed -6 dB I/N within about 7 km.



Link Example #1 – Long Link with Partial Protrusion (WHS328)

ABC Television / Andrew PAR6-65 (1.8°)



1st RLAN protrusion @ 2.3 km

WANTED FS SIGNAL		
FREQUENCY	6963	MHz
FS BANDWIDTH	25	MHz
FS PATH DISTANCE	21.9	km
FS TX POWER	46.2	dBm
FS TX GAIN	38.8	dBi
FS RX GAIN	38.8	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-136.2	dB
FS SIGNAL	**-14.4**	**dBm**
FS NOISE FLOOR	-95.0	dBm

↓↓

AVAILABLE FS C/N	80.6	dB
FS REQUIRED SNR	21.2	dB
FS LINK MARGIN	**59.4**	**dB**
RLAN-INDUCED FMR	2.78	dB
FS+RLAN LINK MARGIN	**56.6**	**dB**

←

RLAN INTERFERENCE		
FREQUENCY	6963	MHz
RLAN BANDWIDTH	80	MHz
RLAN DISTANCE	**2.31**	**km**
RLAN TX POWER	24	dBm
RLAN TX GAIN	6	dBi
FS RX ANT GAIN	38.8	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-116.6	dB
RLAN SIGNAL	**-49.8**	**dBm**
POLARIZATION LOSS	-3	DB
BLDG ENTRY LOSS	-30	DB
RLAN PATTERN MISMATCH	-5	DB
FS OFF-AXIS REJECTION	-2.6	DB
BANDWIDTH MISMATCH	-5.05	DB
ADJUSTED RLAN RSL	**-95.5**	**DBM**
RLAN I/N @ FS RECEIVER	**-0.47**	**DB**

- Link has 80.6 dB of C/N due to high EIRP.
- Including RLAN-induced fade margin reduction (FMR) and required SNR, the link has over 56 dB of residual margin.

Link Example #1 - Long Link with Partial Protrusion (WHS328)

6 GHz RLAN Simulator

Location
NYC WHS328 100m L

RLAN EIRP (dBm)
30

RLAN Bandwidth
80 MHz

RLAN Height (m)
100

Horiz Uncert (m)
10

Vert Uncert (m)
3

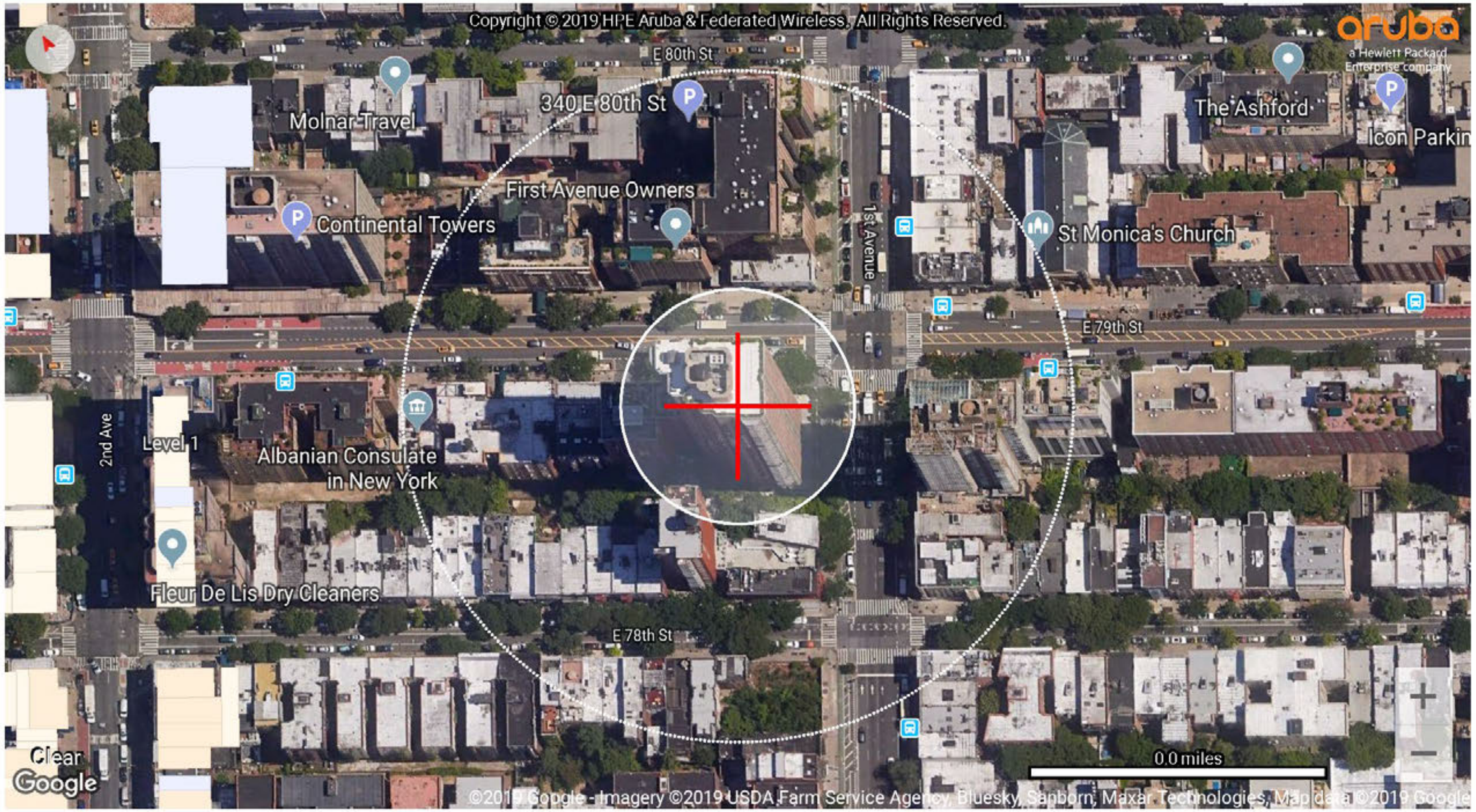
Cell Edge (dBm/MHz)
-95

Penetration Loss (dB)
30

Other Losses (dB)
13

Protection Criteria
-6

FS Antenna
F.1245



Request: 350 E 79th St, New York, NY 10075, USA : Lat 40.77237 Long -73.95321 Cat: Urban Elev: 12.5 m

Incumbent Links

Callsign	Freq	BW	I/N

MHz 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100

UNII-5 | UNII-6 | UNII-7 | UNII-8

20 MHz
40 MHz
80 MHz
160 MHz

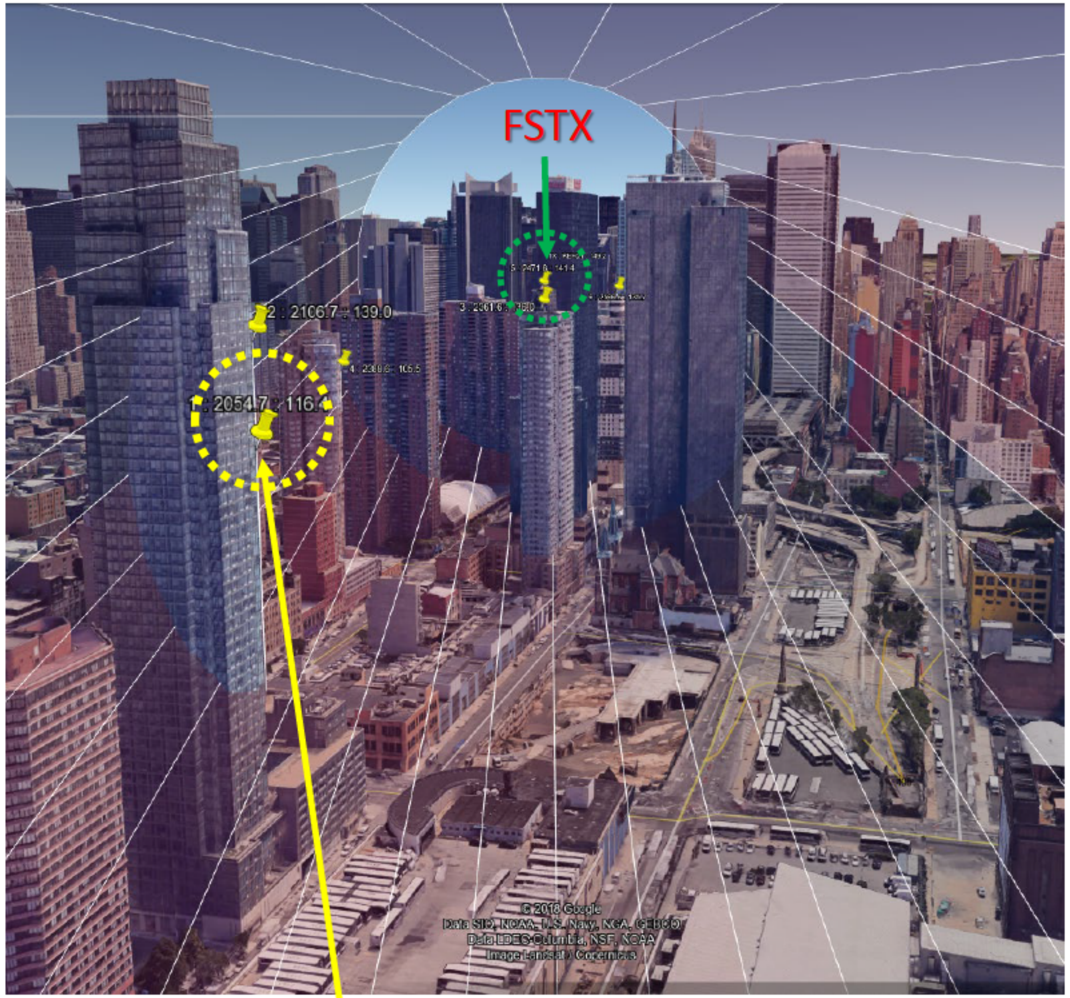
Hide Contours

Check Availability

Show Comms Log

Link Example #2– Worst Case Ultra-Short Path (KEH21)

Port Authority NY NJ / Low gain 30.2 dBi with wide 5° beam



1st RLAN protrusion @ 2 km

WANTED FS SIGNAL		
FREQUENCY	6725	MHz
FS BANDWIDTH	10	MHz
FS PATH DISTANCE	2.6	km
FS TX POWER	28.5	dBm
FS TX GAIN	30.2	dBi
FS RX GAIN	30.2	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-117.4	dB
FS SIGNAL	**-30.5**	**dBm**
FS NOISE FLOOR	-99.0	dBm

AVAILABLE FS C/N	68.5	**dB**
FS REQUIRED SNR	17.2	**dB**
FS LINK MARGIN	**51.4**	**dB**
RLAN-INDUCED FMR	0.84	**dB**
FS+RLAN LINK MARGIN	**50.5**	**dB**

RLAN INTERFERENCE		
FREQUENCY	6725	MHz
RLAN BANDWIDTH	80	MHz
RLAN DISTANCE	**2.05**	**km**
RLAN TX POWER	24	dBm
RLAN TX GAIN	6	dBi
FS RX ANT GAIN	30.2	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-115.3	dB
RLAN SIGNAL	**-57.1**	**dBm**
POLARIZATION LOSS	-3	DB
BLDG ENTRY LOSS	-30	DB
RLAN PATTERN MISMATCH	-5	DB
FS OFF-AXIS REJECTION	-1.6	DB
BANDWIDTH MISMATCH	-9.03	DB
ADJUSTED RLAN RSL	**-105.7**	**DBM**
RLAN I/N @ FS RECEIVER	**-6.72**	**DB**

- Even at point-blank range, I/N for the RLAN protrusion passes -6 dB I/N due to low-gain antennas required to avoid FSRX overload, and off-axis rejection.
- Including RLAN-induced fade margin reduction (FMR) and required SNR, the link still has <u>over 50 dB of margin</u>.

Link Example #2 – Worst Case Ultra-Short Path (KEH21)

6 GHz RLAN Simulator

Location
NYC KEH21 100m 100

RLAN EIRP (dBm)
30

RLAN Bandwidth
80 MHz

RLAN Height (m)
100

Horiz Uncert (m)
10

Vert Uncert (m)
3

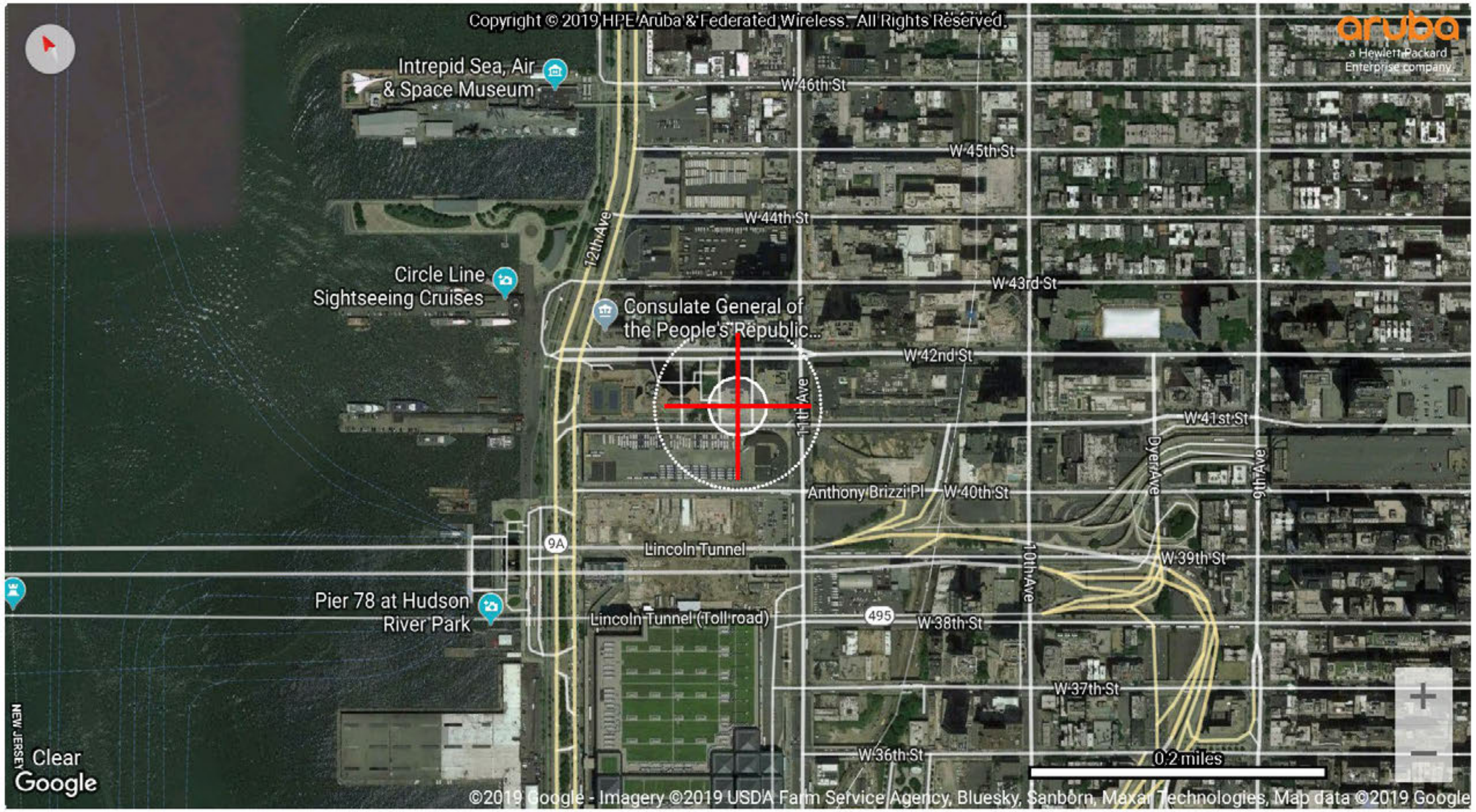
Cell Edge (dBm/MHz)
-95

Penetration Loss (dB)
30

Other Losses (dB)
13

Protection Criteria
-6

FS Antenna
F.1245



Request: 610 W 42nd St, New York, NY 10036, USA : Lat 40.76067 Long -73.99946 Cat: Urban Elev: 4.71 m

Incumbent Links

Callsign	Freq	BW	I/N

MHz 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100

UNII-5 | UNII-6 | UNII-7 | UNII-8

20 MHz
40 MHz
80 MHz
160 MHz

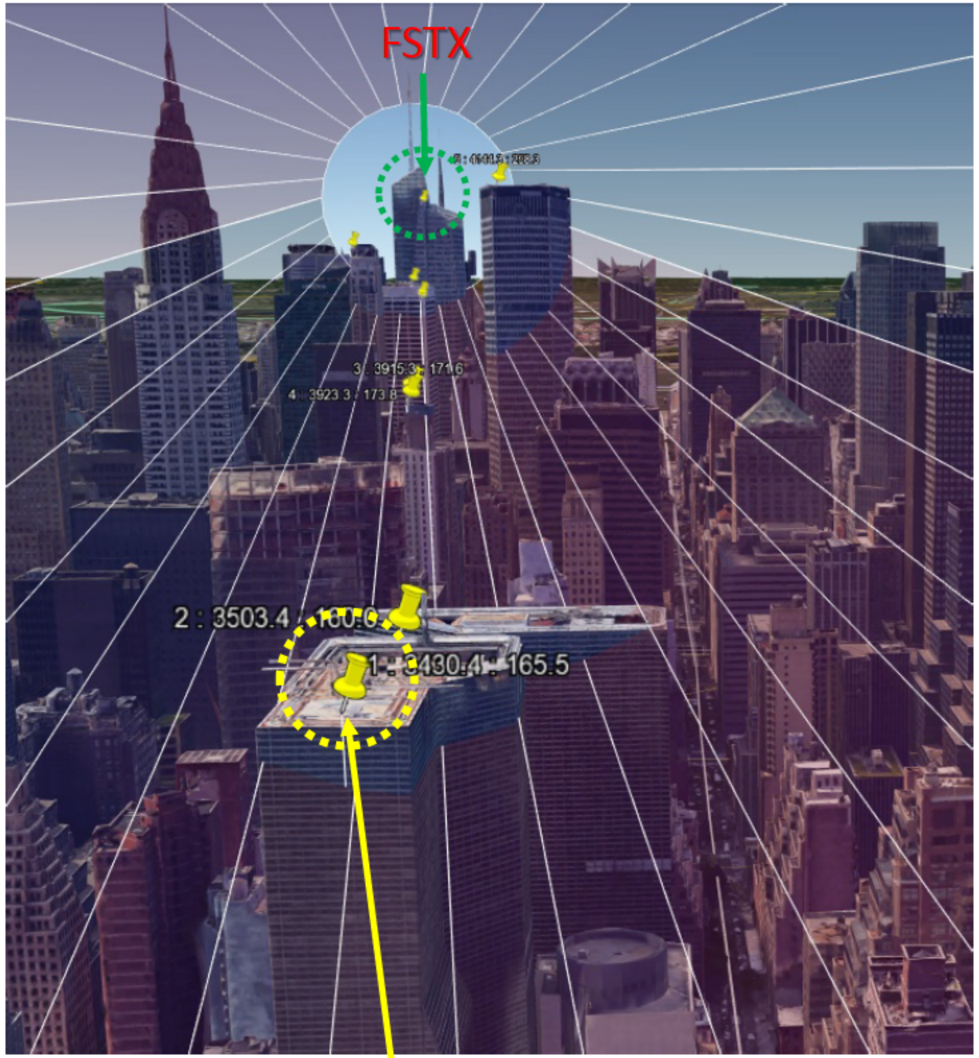
Hide Contours

Check Availability

Show Comms Log

Link Example #3 – Ultra-Short Path (WQHC827)

City of New York / Andrew HP6-59 (1.8°)



1st RLAN protrusion @ 3.43 km

WANTED FS SIGNAL		
FREQUENCY	6034.15	MHz
FS BANDWIDTH	30	MHz
FS PATH DISTANCE	4.9	km
FS TX POWER	23.7	dBm
FS TX GAIN	38.9	dBi
FS RX GAIN	38.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-122.0	dB
FS SIGNAL	**-22.5**	**dBm**
FS NOISE FLOOR	-94.2	dBm

AVAILABLE FS C/N	71.7	**dB**
FS REQUIRED SNR	17.2	**dB**
FS LINK MARGIN	**54.6**	**dB**
RLAN-INDUCED FMR	2.11	**dB**
FS+RLAN LINK MARGIN	**52.5**	**dB**

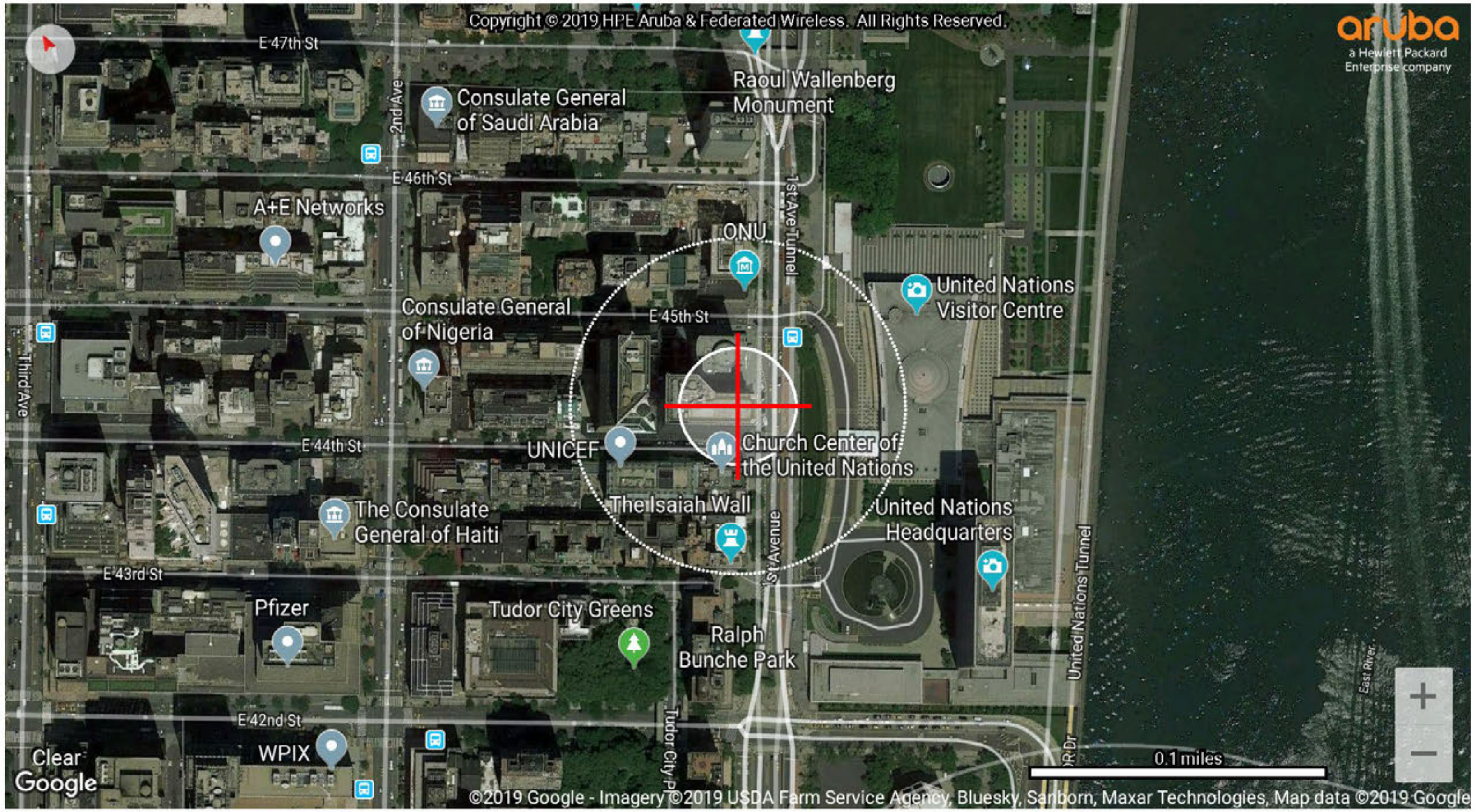
RLAN INTERFERENCE		
FREQUENCY	6034.15	MHz
RLAN BANDWIDTH	80	MHz
RLAN DISTANCE	**3.43**	**km**
RLAN TX POWER	24	dBm
RLAN TX GAIN	6	dBi
FS RX ANT GAIN	38.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-118.8	dB
RLAN SIGNAL	**-51.9**	**dBm**
POLARIZATION LOSS	-3	DB
BLDG ENTRY LOSS	-30	DB
RLAN PATTERN MISMATCH	-5	DB
FS OFF-AXIS REJECTION	-2.1	DB
BANDWIDTH MISMATCH	-4.26	DB
ADJUSTED RLAN RSL	**-96.3**	**DBM**
RLAN I/N @ FS RECEIVER	**-2.05**	**DB**

- Main beam shaves top of building at 3.4 km. An RLAN in this location would yield -2.05 dB I/N.
- Link still has <u>over 52 dB residual margin</u> after including required SNR and RLAN FMR. Link is too short for significant fading.

Link Example #3 – Ultra-Short Path (WQHC827)

6 GHz RLAN Simulator

Location
NYC WQHC827 100m
RLAN EIRP (dBm)
30
RLAN Bandwidth
80 MHz
RLAN Height (m)
100
Horiz Uncert (m)
10
Vert Uncert (m)
3
Cell Edge (dBm/MHz)
-95
Penetration Loss (dB)
30
Other Losses (dB)
13
Protection Criteria
-6
FS Antenna
F.1245



Request: 1 United Nations Plaza, New York, NY 10017, USA : Lat 40.75042 Long -73.96896 Cat: Urban Elev: 13.12 m

MHz 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100

UNII-5 | UNII-6 | UNII-7 | UNII-8

20 MHz
40 MHz
80 MHz
160 MHz

Hide Contours

Check Availability

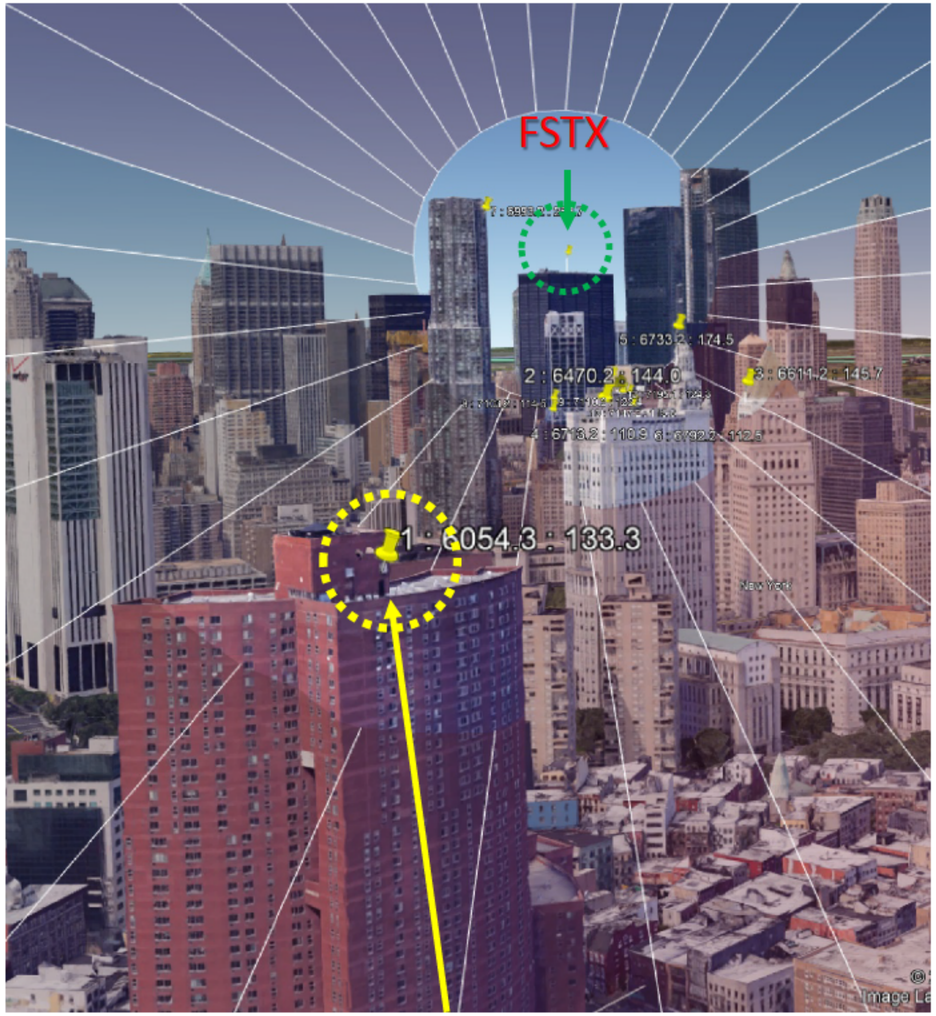
Incumbent Links

Callsign	Freq	BW	I/N

Show Comms Log

Link Example #4 – Short Path (WQHC635)

City of New York / Andrew PAR6X-59 (1.9°)



1st RLAN protrusion @ 6.05 km

WANTED FS SIGNAL		
FREQUENCY	6004.5	MHz
FS BANDWIDTH	30	MHz
FS PATH DISTANCE	7.4	km
FS TX POWER	25.4	dBm
FS TX GAIN	37.9	dBi
FS RX GAIN	37.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-125.5	dB
FS SIGNAL	**-26.3**	**dBm**
FS NOISE FLOOR	-94.2	dBm

↓↓

AVAILABLE FS C/N	67.9	dB
FS REQUIRED SNR	17.2	dB
FS LINK MARGIN	**50.7**	**dB**
RLAN-INDUCED FMR	0.68	dB
FS+RLAN LINK MARGIN	**50.1**	**dB**

RLAN INTERFERENCE		
FREQUENCY	6004.5	MHz
RLAN BANDWIDTH	80	MHz
RLAN DISTANCE	**6.05**	**km**
RLAN TX POWER	24	dBm
RLAN TX GAIN	6	dBi
FS RX ANT GAIN	37.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-123.7	dB
RLAN SIGNAL	**-57.8**	**dBm**
POLARIZATION LOSS	-3	DB
BLDG ENTRY LOSS	-30	DB
RLAN PATTERN MISMATCH	-5	DB
FS OFF-AXIS REJECTION	-1.9	DB
BANDWIDTH MISMATCH	-4.26	DB
ADJUSTED RLAN RSL	**-102.0**	**DBM**
RLAN I/N @ FS RECEIVER	**-7.73**	**DB**

- First protrusion cited by Commscope meets IPC requirement at -7.73 dB I/N considering off-axis rejection and typical losses.
- Link has over 50 dB residual margin after including required SNR and RLAN FMR. Link is too short for significant fading.

Link Example #4 – Short Path (WQHC635)

6 GHz RLAN Simulator

Location: NYC Confucius Plaza

RLAN EIRP (dBm): 30

RLAN Bandwidth: 80 MHz

RLAN Height (m): 100

Horiz Uncert (m): 10

Vert Uncert (m): 3

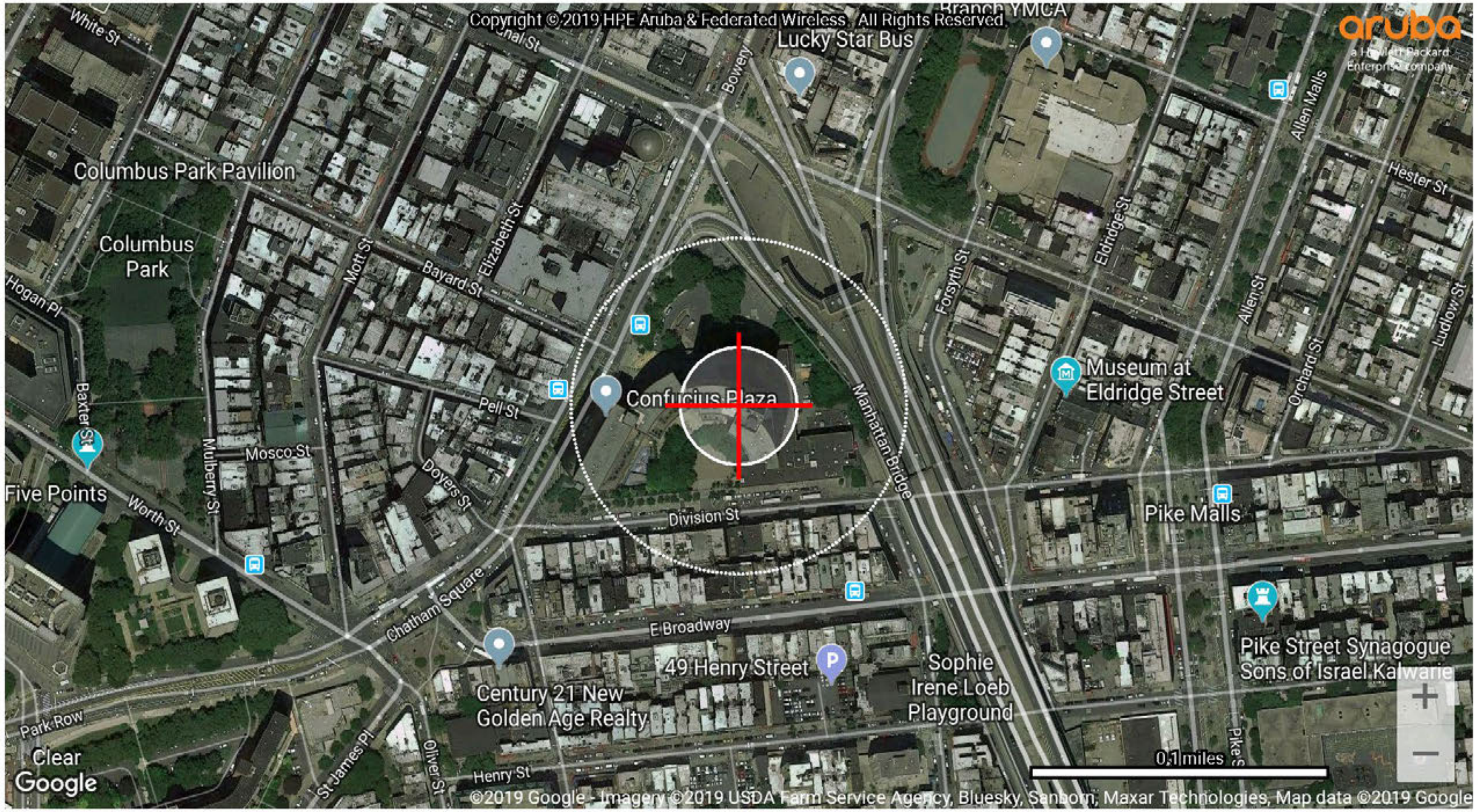
Cell Edge (dBm/MHz): -95

Penetration Loss (dB): 30

Other Losses (dB): 13

Protection Criteria: -6

FS Antenna: F.1245



Request: 37 Bowery, New York, NY 10002, USA : Lat 40.71473 Long -73.99587 Cat: Urban Elev: 12.56 m

MHz 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100

UNII-5 | UNII-6 | UNII-7 | UNII-8

20 MHz
40 MHz
80 MHz
160 MHz

Incumbent Links

Callsign	Freq	BW	I/N

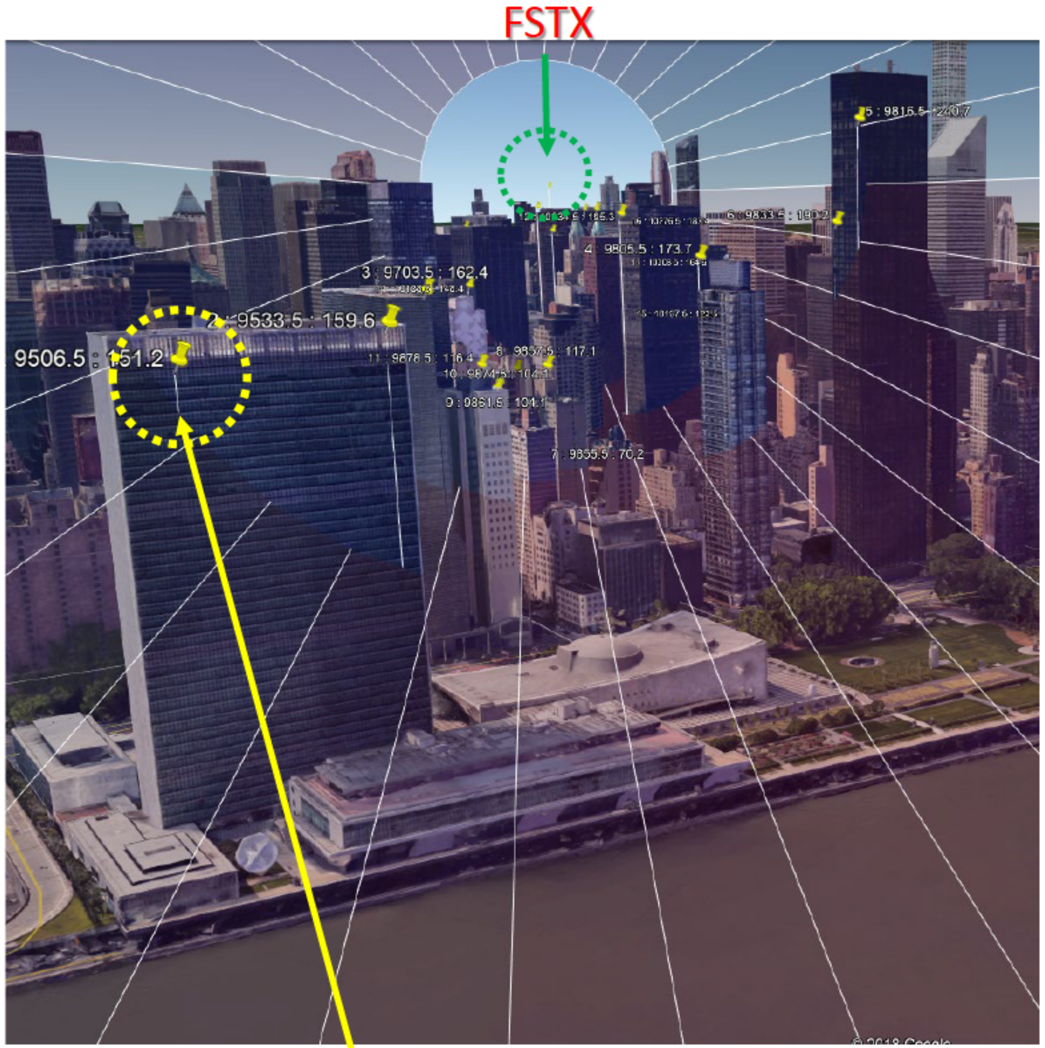
Hide Contours

Check Availability

Show Comms Log

Link Example #5 – Short Path (WNTB247)

NY Transit Authority / Commscope P6-65D (1.7°)



1st RLAN protrusion @ 9.5 km

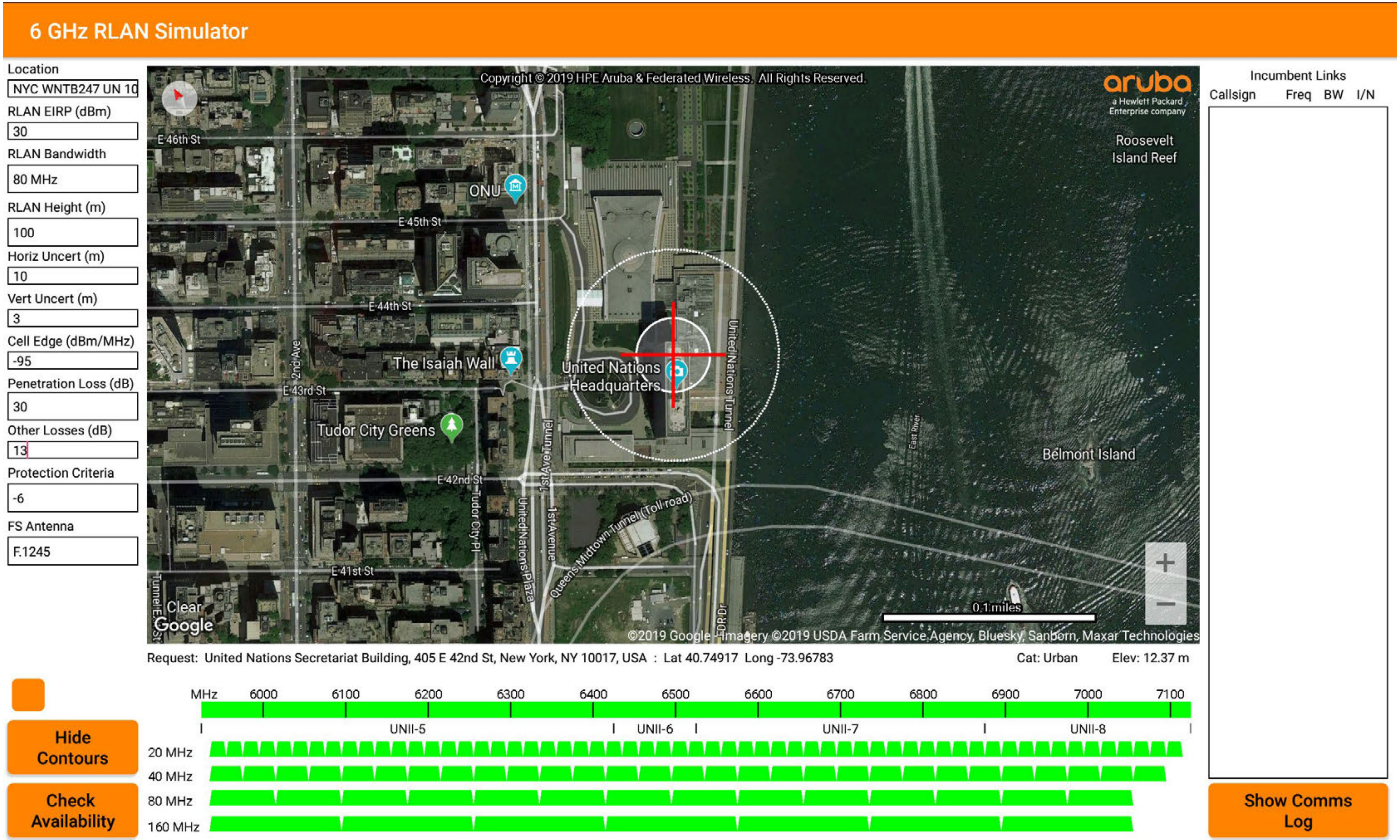
WANTED FS SIGNAL		
FREQUENCY	6795	MHz
FS BANDWIDTH	5	MHz
FS PATH DISTANCE	11.2	km
FS TX POWER	18.1	dBm
FS TX GAIN	39.9	dBi
FS RX GAIN	39.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-130.2	dB
FS SIGNAL	**-34.3**	**dBm**
FS NOISE FLOOR	-102.0	dBm

AVAILABLE FS C/N	**67.7**	**dB**
FS REQUIRED SNR	**17.2**	**dB**
FS LINK MARGIN	**50.6**	**dB**
RLAN-INDUCED FMR	**0.29**	**dB**
FS+RLAN LINK MARGIN	**50.3**	**dB**

RLAN INTERFERENCE		
FREQUENCY	6795	MHz
RLAN BANDWIDTH	80	MHz
RLAN DISTANCE	**9.50**	**km**
RLAN TX POWER	24	dBm
RLAN TX GAIN	6	dBi
FS RX ANT GAIN	39.9	dBi
FS FEEDER LOSS	-2	dB
FSPL ATTENUATION	-128.7	dB
RLAN SIGNAL	**-60.8**	**dBm**
POLARIZATION LOSS	-3	DB
BLDG ENTRY LOSS	-30	DB
RLAN PATTERN MISMATCH	-5	DB
FS OFF-AXIS REJECTION	-2.8	DB
BANDWIDTH MISMATCH	-12.04	DB
ADJUSTED RLAN RSL	**-113.6**	**DBM**
RLAN I/N @ FS RECEIVER	**-11.63**	**DB**

- An RLAN at first protrusion would yield -11.63 dB I/N.
- Link still has over 50 dB residual margin after including required SNR and RLAN FMR.

Link Example #5 – Short Path (WNTB247)



New Link Example: FCC Building (WPQT500)

6 GHz RLAN Simulator

Location

DC FCC Building 100r

RLAN EIRP (dBm)

30

RLAN Bandwidth

80 MHz

RLAN Height (m)

100

Horiz Uncert (m)

10

Vert Uncert (m)

3

Cell Edge (dBm/MHz)

-95

Penetration Loss (dB)

30

Other Losses (dB)

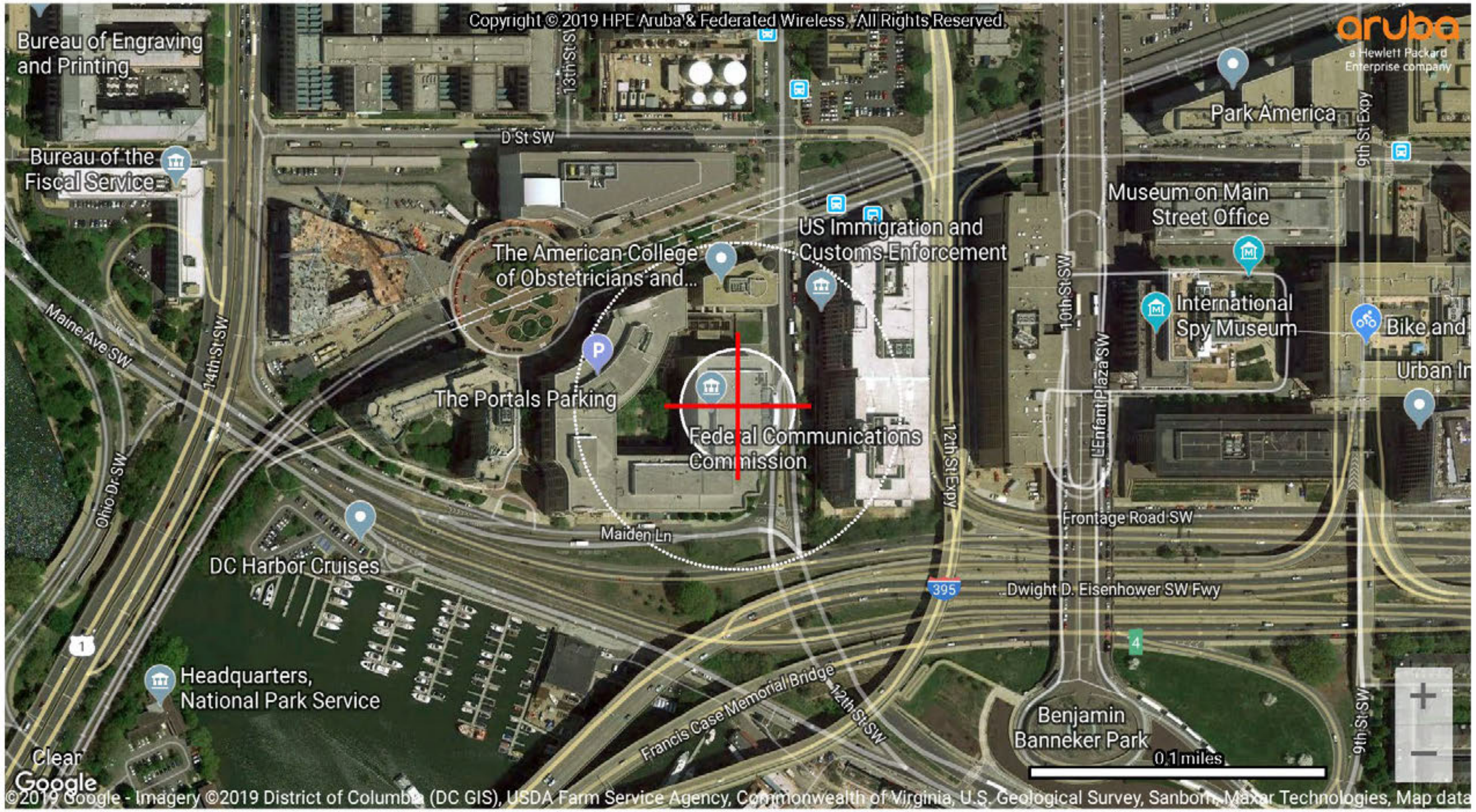
13

Protection Criteria

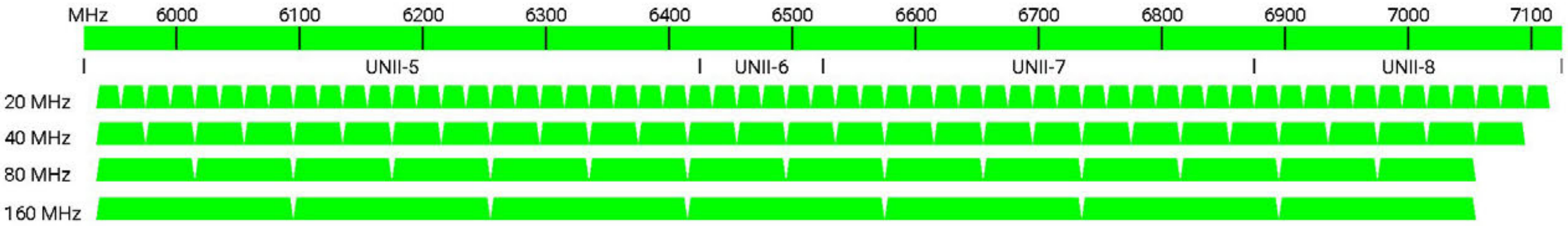
-6

FS Antenna

F.1245



Request: 445 12th St SW, Washington, DC 20554, USA : Lat 38.8835 Long -77.02842 Cat: Urban Elev: 7.28 m



Incumbent Links

Callsign	Freq	BW	I/N

Hide Contours

Check Availability

Show Comms Log